Device and method in the transfer of the paper or board web in the paper or boardmachine

The invention concerns an equipment and a method in the transfer of a paper/board web in a paper or board machine.

The running of the web in the initial end of the dryer section is often the most critical stage, because the percentage of moisture in the web is still considerably high and the risk of break of the web is then also higher than in the final end of the dryer section. In conventional dryer sections with single-wire draw, thus, the first drying group is, as a rule, the drying group that determines the speed of the whole machine. In the prior art, attempts have been made to minimize these problems of runnability by first shifting from twin-wire draw to single-wire draw, by developing various devices that stabilize the run of the web, such as, for example, UR blow boxes, and by substituting for the reversing cylinders in the single-wire draw by suction rolls, such as, for example, Vac rolls. Further, in order to provide a more efficient support, the vacuum levels in the suction rolls have been increased, which, of course, increases the consumption of energy in the paper machine. As is known from the prior art, attempts have also been made to reduce the problems of runnability in the initial end of the dryer section by, in the beginning of the dryer section, fitting a substantially horizontal wire draw on which the web is dried by blowing hot air against the web. One problem in this solution is the space taken by the impingement drying arrangements. In the present patent application, it is suggested that, at least in the first drying group, in stead of an ordinary drying wire, a so-called transfer belt is employed, which is such a belt element that transfers the web whose face is smooth and whose adhesion properties are good. The web adheres to the face of the transfer belt. Further, the transfer belt is impenetrable by air and water. When a transfer belt in accordance with the invention is used, no separate web support blowing or equivalent is needed, but the transfer belt alone operates as

an element that transfers and affixes the web. Owing to the belt, the running of the web is stable. Owing to said web affixing property, the web remains on the face of the transfer belt also on curved runs of the web. In a group of drying cylinders with single wire draw and provided with a transfer belt, it is, thus, not necessary to employ so-called suction rolls as reversing cylinders.

When the speeds of paper machines become higher, said problems of runnability, in particular in the beginning of the dryer section, are emphasized. With increasing running speeds, it has become necessary to avoid open draws of the web also between the press section and the dryer section. As is known from the prior art, it has been suggested that said draw is closed, among other things, by picking up the web directly from the face of a press roll by means of a suction roll onto a drying wire. Also, in a way known from the prior art, a transfer belt has been used in the press section, which belt does not receive water and does not wet the web and from which belt the web has been picked up as a closed draw onto the drying wire of a cylinder group or directly onto the face of the first cylinder. Said technique has not yet become very common. One potential problem is the transfer of the web from the transfer belt to the dryer section, and an embodiment of the present invention attempts to reduce this problem.

In view of avoiding the problems mentioned above, in the method in accordance with the present invention, the web is made to adhere to the outer face of a transfer belt substantially not receiving water in the press section, for example in its last press nip, and the web is passed as a closed draw into the dryer section.

Thus, the solution in accordance with the invention includes a transfer belt loop, which does substantially not receive water and whose outer face is capable of adhering to the paper web and which has been fitted to run as a continuous loop at least through the last press in the press section and further over drying cylinders. The transfer belt H_{100} is favourably of the type described in the *US Patent 5,298,124.*

By means of the method and the concept of equipment in accordance with the present invention, it is possible to accomplish improved properties of smoothness of the faces of paper or board to be manufactured and more stable running of the web, which is partly based on the use of a transfer belt which has a relatively smooth face and which is applied and arranged in accordance with the present invention.

The invention is usable with further increasing running speeds in new machines, but it also offers an easy mode of improving the runnability in the initial part of the dryer section in existing paper machines. An existing wire is substituted for by a transfer belt in accordance with the invention.

The invention is characterized in what is stated in the patent claims.

In the following, the invention will be described in detail with reference to some exemplifying embodiments of the invention illustrated in the figures in the accompanying drawings, the invention being by no means strictly confined to the details of said embodiments.

Figure 1 shows a construction of a dryer section in accordance with the invention, which comprises a transfer belt draw in stead of a conventional single-wire draw, which transfer belt draw preferably extends to the press, i.e. runs through a press nip.

Figure 2 shows a dryer section provided with a transfer belt draw, comprising impingement drying units in connection with drying cylinders and reversing rolls, through which units a drying medium is supplied to increase the drying capacity.

Figure 3A shows a conventional prior-art single-wire draw arrangement which is used in a dryer section concept in accordance with the invention in its second group R_{II} of drying cylinders.

Figure 3B shows a transfer belt draw in accordance with the invention employed in the first group R_I of drying cylinders. The embodiment shown in Fig. 3B corresponds to Fig. 2, in which impingement drying units have been fitted in connection with the drying cylinders and with the reversing rolls.

Figure 4 shows an embodiment of the invention in which the web W is passed out of connection with the face of the backup roll of the extended-nip roll in an extended-nip press by means of an adhesion nip onto a transfer roll and further into connection with a transfer belt in accordance with the invention in the group of drying cylinders.

Figure 5 shows an embodiment of the invention in which the web is passed from the face of the backup roll of an extended-nip roll directly into connection with a transfer belt.

Figure 6A shows an embodiment of the invention in which the web is passed into the first group of drying cylinders in the dryer section from the face of a press felt.

Figure 6B shows an embodiment of the invention in which the web is passed into a group of drying cylinders in the dryer section from the face of a centre roll in the press by bringing the transfer belt into contact with the face of the centre roll in the press.

Figure 7A shows the transfer of the web from the group R_I of drying cylinders into the following group R_{II} of drying cylinders by, between the groups, employing a separate transfer suction roll and a transfer fabric.

Figure 7B shows an embodiment of the invention in which exclusively a transfer suction roll is employed between the groups R_I and R_{II} of drying cylinders.

Figure 8 shows an embodiment of the invention in which the transfer belt of a group of drying cylinders has been fitted to run through a press nip and in which, in the

first group R_I of drying cylinders, the drying cylinders are placed in upper positions and the reversing rolls in lower positions, and in which solution the web is transferred from the first group R_I of drying cylinders into a group R_{II} of drying cylinders provided with twin-wire draw.

Figure 9A shows an embodiment of the invention in which the transfer belt is passed from the last press in the press section through a press nip so that, inside the loop of the transfer belt, there is a large-diameter roll, along with whose face two impingement drying units and their impingement hoods have been fitted.

Figure 9B shows an embodiment of the invention which is in the other respects similar to the embodiment shown in Fig. 9A, but in the embodiment of Fig. 9B, before the what is called impingement drying roll, an impingement drying unit is placed, by whose means pre-heating of the web is carried out before the impingement drying roll proper.

Figure 10 shows an embodiment that is in the other respects similar to Fig. 9A, but in the embodiment shown in Fig. 10, the what is called impingement drying roll has been substituted for by a roll with an even larger diameter in order to increase the length of the impingement drying zone.

Figure 11 shows an embodiment of the invention in which the what is called impingement drying roll has been substituted for by an oblong impingement drying hood. The impingement drying unit has been fitted in connection with a linear run of the transfer belt, and after the impingement drying unit the web is transferred from the transfer belt into the first group of drying cylinders in the dryer section.

Figure 12 shows an embodiment in the other respects similar to Fig. 11, but in the solution of Fig. 12 the length of the impingement drying zone has been increased by fitting the support rolls in a vertical stack, in which case the web and the run of the transfer belt run first along with the support rolls upwards and from the last support

roll along with the corresponding support rolls downwards. Impingement drying units have been fitted at both sides of the support rolls.

Figure 13 shows a construction in the other respects similar to Fig. 11, but in this embodiment the beginning of the dryer section K includes suction boxes right after the transfer suction roll.

In the construction shown in Fig. 1, the single-wire draw has been substituted for by a transfer belt draw. Further, in the dryer section concept shown in Fig. 1, besides through the first group R_I of drying cylinders in the dryer section K, the transfer belt H_{100} also runs through the press section P. The transfer belt H_{100} runs as a closed loop through the nip N_1 between the press rolls $10a_1$,$10a_2$ in the press P_N. In the solution in accordance with the invention, in the way shown in Fig. 1, the paper or board web W adheres, in the nip N_1 between the press rolls $10a_1$ and $10a_2$ in the press 10, to the transfer belt H_{100} passed through the press nip N_1 and runs on the face of the transfer belt into the dryer section K to its first group R_I of drying cylinders. Thus, the transfer belt H_{100} has been passed at least through the last press nip N_1 in the press P_N in the press section P. The web is passed to the press P_N by means of the suction of the pick-up roll 13b so that the web is first transferred onto a transfer felt H_N and kept along with the face of the felt by means of the holding suction produced by a blow box f. Thus, the transfer felt H_N has been passed through the nip N_1 and guided by the felt guide rolls $13a_1$,$13a_2$... The press P_N is preferably an extended-nip press, whose upper roll $10a_1$, as is shown in Fig. 1, is a so-called extended-nip roll and comprises a resilient belt mantle of an extended-nip roll. The upper extended-nip roll $10a_1$ in the extended nip comprises a loading shoe, which is pressed towards the backup roll, in which connection the resilient belt mantle complies with the face form determined by the loading shoe. From the drying group R_I the web W is transferred to the second drying group R_{II}, which is conventional, i.e. comprises a conventional single-wire draw with a conventional wire H_2. The wire H_2 is guided as a closed loop over the wire guide rolls $14a_1$,$14a_2$. It should, however, be emphasized in this connection that the invention is also usable in connection with other prior-art press solutions, besides in connection with an

extended-nip press. The press may advantageously also consist of more than one dewatering press nips.

A significant drawback of the press felts that have been employed in prior-art press sections has been an effect of rewetting the web and a tendency of contamination. A transfer belt H_{100} in accordance with the invention does substantially not receive water, is impenetrable by air, smooth, and its outer face is capable of adhering to the paper web. In such a case, the paper web can be made to adhere to the outer face of the transfer belt loop without rewetting of the web. On the transfer belt the web (paper or board web) can be passed as a closed and supported draw from the press to the dryer section K to the first drying group R_I in the dryer section and from said group into the conventional group R_{II} of drying cylinders provided with single-wire draw, which group comprises conventional suction rolls S_1,S_2... of the **VacRoll** type.

From the nip N_1 formed by the press rolls $10a_1$ and $10a_2$, which nip is preferably an extended nip, the web is carried on the top face of the transfer belt H_{100} onto the first drying cylinder K_1 in the first group R_I of drying cylinders in the preliminary dryer section, i.e. in the dryer section K, which cylinder K_1 is a steam-heated drying cylinder. The web W runs further along the face of the drying cylinder K_1 between the transfer belt H_{100} and the face of the drying cylinder K_1 further onto an ordinary reversing roll E_1 and remains in contact with the face of the transfer belt H_{100} also in connection with the reversing roll E_1, which is an ordinary, non-heated roll construction. The transfer belt H_{100} has been passed, besides over the drying cylinders K_1,K_2... and over the reversing rolls E_1,E_2 and through the nip N_1, also over the transfer belt guide rolls $12a_1$,$12a_2$...$12a_N$. The web W runs meandering in loop shape in the group R_I of drying cylinders in the dryer section, i.e. from the reversing roll E_1 further onto the second heated drying cylinder K_2 in the group R_I and further in the group R_{II} of drying cylinders. Thus, in the drying group R_I, the reversing rolls E_1,E_2...E_n can be ordinary smooth-faced rolls. The rolls may also have grooved faces. They do not need inside suction or perforations, by whose means, in a conventional dryer section provided with single-wire draw, the web W

is affixed at the suction cylinders to the wire face. The properties of the transfer belt H_{100} are such that the web W remains in contact with the face of the transfer belt also in the loop-shaped meandering web run formed by conventional reversing rolls E_1,E_2... not provided with suction. Out of connection with the drying cylinder K_3, the web W is transferred further onto the transfer suction roll D_1 in the second drying group R_{II}. Being transferred by means of the suction of the transfer suction roll D_1, the web W is separated from the transfer belt H_{100} and is transferred further, out of connection with the face of the transfer belt H_{100}, into connection with the wire H_2 in the second group R_{II} of drying cylinders in the dryer section K and further in said conventional group R_{II} of drying cylinders.

In the beginning of the dryer section, the strength of the web W is lowest, because the water content in the web is still high. Thus, as a rule, the beginning of the dryer section has determined the maximal speed at which it has been possible to run the paper/board machine. Thus, as a rule, the first drying group R_I has determined the maximal speed of the dryer section and, thus, also of the whole paper/board machine. When a transfer belt H_{100} is used in the first group R_I of drying cylinders in the dryer section K, the speed of the whole paper/board machine can be increased to a significant extent. When a transfer belt H_{100} is employed in stead of a conventional wire, it is possible to stabilize and to speed up the draw of the web to a considerable extent in the initial end of the dryer section. When a transfer belt H_{100} is used, the run of the web W is stable and steady, and there is no risk of web break. The web W is transferred as a closed draw from the press into the dryer section into its group R_I of drying cylinders and from said group into the second group R_{II}. There are no open web draws in the first group R_I of drying cylinders in accordance with the invention in the dryer section K.

As is shown in Fig. 1, the web is passed from the preliminary dryer section in accordance with the invention, i.e. from the first drying group R_I in accordance with the invention, to the second group R_{II} of drying cylinders in the dryer section, which group is a conventional group of drying cylinders provided with single-wire draw, in which the wire has been fitted to run over conventional suction rolls S_1,S_2... of

the **VacRoll** type. The suction rolls S_1,S_2... comprise a perforation passing through the roll mantle and opening into the grooves placed on the mantle face of the roll, on one hand, and into the interior of the roll, on the other hand, and a vacuum is applied to the roll interior. In such a case, a suction and holding force can be applied to the grooves provided in the circumferential direction on the face of the roll mantle and, further, to the web W that is passed outside. The wire is a conventional fabric permeable to air and used in single-wire draw. Even though, in Fig. 1, the group R_{II} is a normal group with single-wire draw, in some cases, in particular in modernizations by whose means attempts are made expressly to eliminate problems of runnability in the beginning of the dryer section, in accordance with the present invention, the group R_{II} may also be a drying group of a different type, for example a Uno-Run group or even a group with twin-wire draw.

In traditional cylinder drying, in the first group, just very little evaporation of water present in the web takes place through the wire. This is why, employment of a belt impenetrable by air and water in compliance with the present invention does not reduce the drying efficiency to a substantial extent. On the contrary, as the web follows the belt reliably, the temperature of the cylinders can be raised without a risk that the web might follow the cylinder face. If it is desirable to increase the drying capacity further, it is possible to use an arrangement in accordance with Fig. 2.

In view of increasing the drying capacity, the group R_I of drying cylinders in the dryer section shown in Fig. 2 is additionally provided with impingement drying boxes $11a_1$,$11a_2$... placed in connection with the reversing cylinders E_1,E_2..., through which boxes hot air / hot gas / hot steam is blown into connection with the web W in order to increase the drying capacity. The construction of the dryer section shown in Fig. 2 is in other respects similar to the construction of the dryer section shown in Fig. 1. In a solution of equipment in accordance with the invention, the impingement drying units can be placed either exclusively in connection with steam-heated drying cylinders or, as is shown in Fig. 2, also in connection with the reversing cylinders E_1,E_2... In principle, similar impingement drying can also be

arranged in connection with the drying cylinders K_1,K_2..., but its capacity remains low because of the impenetrable belt.

Fig. 3A shows a prior-art conventional single-wire draw which is employed in the group R_{II} of drying cylinders, i.e. in the second group of drying cylinders. An ordinary drying wire H_2 has been passed from the drying cylinder K_1' onto the suction roll S_1 and from the suction roll S_1 onto the second drying cylinder K_2' and further in the group R_{II} of drying cylinders. As is shown in the figure, the suction cylinder S_1 comprises grooves u_1,u_2 on its face, in which grooves the holes a_1,a_2 passing through the mantle S' of the suction cylinder terminate. A vacuum is applied to the interior of the suction cylinder, by whose means a circumferential holding force can be applied to the web W. In the way shown in Figs. 1 and 2, blow boxes B_1 and B_2 or equivalent apparatuses that stabilize the running of the web can also be fitted in the pockets formed by the cylinders and by the suction roll.

The dryer section concept in accordance with the invention can comprise a number of groups R_{II},R_{III},R_{IV}... drying cylinders, which groups are, after the first group of drying cylinders, ordinary groups of drying cylinders provided with single-wire draw. A transfer belt can also be employed in other groups of drying cylinders besides in the first group of drying cylinders.

Fig. 3B is an axonometric illustration of a group R_I as shown in Fig. 2, wherein both the drying cylinders and the smooth-faced reversing cylinders are provided with impingement drying units $11a_1$,$11a_2$..., through which a heat transfer medium, preferably steam or hot air, is passed into connection with the web W. As is shown in the figure, the reversing rolls E_1,E_2... are smooth-faced reversing rolls. The transfer belt H_{100} has been passed over the smooth, non-perforated roll faces e of the reversing rolls E_1,E_2...

In the following Figs. 4 to 8, different modes of transfer of the web to the dryer section K and from the first group of drying cylinders in the dryer section to the second group of drying cylinders will be illustrated. However, it is an essential

feature of all of the embodiments to be described in the following that at least the group R_I of drying cylinders is a drying group provided with a transfer belt H_{100} similar to what has been described above in relation to Fig. 1.

Fig. 4 shows an embodiment of the invention in which, similarly to the embodiment shown in Fig. 1, the group R_I of drying cylinders in the dryer section K consists of drying cylinders K_1,K_2,K_3 and reversing cylinders E_1,E_2 and E_3. As is the case in the embodiment shown in Fig. 1, the drying cylinders K_1,K_2,K_3 are steam-heated smooth-faced drying cylinders, and the reversing cylinders E_1,E_2... are conventional smooth-faced rolls. In the embodiment shown in the figure, between the drying groups R_I and R_{II}, there is a smooth-faced roll K_{10}, which may also be a cylinder, such as a drying cylinder. In accordance with the invention, the group R_I includes a transfer belt H_{100}, and, as is shown in the figure, the web W is transferred, meandering in loop shape, along with the transfer belt H_{100}, to which the web adheres by means of adhesion, further in the group of drying cylinders. The web is transferred into the group R_I of drying cylinders from the press P_N out of connection with the press rolls $10a_1$ and $10a_2$, which are preferably rolls in an extended-nip press. As is shown in the figure, the web W is transferred further, adhering to the smooth face of the upper backup roll $10a_2$ of the smooth-faced extended-nip roll $10a_1$, by means of an adhesion nip V, onto the upper transfer roll S_{100}, for example a suction roll, and from its connection into connection with the transfer belt H_{100}, to whose face the web W adheres. From the group R_I the web is transferred into connection with the cylinder or smooth-faced roll K_{10} and further into connection with the second drying group R_{II} between the wire H_2 and the cylinder K_{10} and further in the group R_{II}. The group R_{II} can be a conventional group of drying cylinders with single-wire draw, in which, between the drying cylinders, there are VacRoll rolls S_1,S_2..., as is the case also in the embodiment shown in Fig. 1. In this embodiment, the adhesion nip V may also operate as a so-called equalizing press, by whose means substantially the same smoothness is achieved for both faces of the web.

Fig. 5 shows an embodiment of the invention in which the group R_I of drying cylinders in the dryer section comprises a transfer belt H_{100}, as is the case in the preceding embodiments, but in which solution the web W is picked up into connection with the transfer belt H_{100} out of connection with the press P, preferably out of connection with the backup roll $10a_2$ of the extended-nip roll $10a_1$ of an extended-nip press. After the nip N_1 in the press P_N, the web W moves a certain distance on the face of the backup roll $10a_2$ of the press P_N, which roll is preferably a smooth-faced roll, and reaches contact with the transfer belt H_{100}, which has been brought into connection with said roll face, and adheres to the belt. In the embodiment of the figure, the guide roll $12a_n$ has been fitted in such a way in connection with the lower roll $10a_2$ of the press P_N that the roll $12a_n$ presses the transfer belt H_{100} into contact with the lower roll $10a_2$ of the press P_N. Thus, as is shown in the figure, the web W is transferred along with the transfer belt H_{100}, meandering in loop shape, over the drying cylinders K_1,K_2... and the conventional smooth-faced reversing rolls E_1,E_2..., in the same way as in the embodiment shown in Fig. 1, in the group R_I onto the transfer suction roll S_{100}, which is placed between the groups R_I and R_{II} and which may comprise a wire sock on its face, in which connection a suction effect is applied to the web W in the position between the groups. In this way the web is transferred from the group R_I to the group R_{II}, which may be a conventional group of drying cylinders with single-wire draw which includes Vac rolls S_1,S_2...

Fig. 6A shows an embodiment of the invention in which the web W is passed from the press P to the dryer section K into its first group R_I of drying cylinders, which comprises a transfer belt H_{100} as described above. In the embodiment of Fig. 6A, the web W is passed, while adhering to the transfer belt H_{100}, from the drying cylinder K_1 onto the smooth-faced reversing roll E_1 and further onto the drying cylinder K_2 placed in a different position of height, and further in the group of drying cylinders. Thus, the web is kept in contact with the face of the transfer belt H_{100} constantly while the web adheres to the transfer belt by means of adhesion. Thus, Vac Rolls or equivalent are not needed, and blow boxes and equivalent are likewise not needed. From the press P_N, out of the nip N_1, the web W is passed in between the press felts H_N and H_{N+1}. The web W is transferred from the felt H_N

onto the transfer belt H_{100} of the group R_I, as is the case in the embodiment shown in Fig. 1, and from the group R_I into the group R_{II}, which group R_{II} can be, as is shown in the figure, for example, a twin-wire group comprising the wires H_{200},H_{201}. Thus, from the group R_I of drying cylinders the web is transferred, for example, into a conventional twin-wire group R_2 by means of a transfer suction roll D_{10}. Thus, the group R_{II} of drying cylinders comprises conventional wires H_{200},H_{201} and drying cylinders K_1',K_1" and K_2',K_2"...

Fig. 6B shows an embodiment in which the web is transferred into the first group R_I of drying cylinders in the dryer section K out of connection with the centre roll 50 of the press section P. As is shown in the figure, the web W is brought through the nip N_{10} into connection with the centre roll 50 and transferred on the face of the centre roll into the second press nip N_{20} and further, along the face 50' of the centre roll 50, through the press nip N_2 and further from the face 50' of the centre roll 50 into connection with the transfer belt H_{100} of the group R_I, which transfer belt H_{100} has been brought into contact with the face of the centre roll 50 by means of the roll T. As is shown in the figure, the group R_{II} may be, for example, a group with twin-wire draw or, as is shown in Fig. 1, an ordinary group with single-wire draw. The group R_I is of the same sort as the group R_I in Fig. 1. The group R_{II} is similar to that shown in the embodiment of Fig. 6A. It is obvious that the group can also be an ordinary group of drying cylinders with single-wire draw. The felt draws in the press P have been denoted with H_{n+2} and H_{n+3}.

Fig. 7A shows a separate transfer fabric loop H_{300}, which is placed between the groups R_I and R_{II} and which has been passed over the suction roll S_{200}, which suction roll S_{200} is placed between the groups R_I,R_{II}. The web W is transferred out of connection with the transfer belt H_{100} of the group R_I into connection with the transfer wire H_3 and further into the second drying group R_{II}. In the embodiment shown in the figure, the group R_1 comprises the transfer belt H_{100}, the smooth-faced reversing cylinders E_1 and E_2, and the drying cylinders K_1,K_2... As is shown in the embodiment shown in Fig. 1, the web runs, adhering to the transfer belt H_{100}, up to the end of the group R_I, where the web W is separated from the face of the

transfer belt H_{100} by means of the transfer wire H_3 and the transfer suction roll S_{200}, the web being transferred along with the transfer wire H_3 into the second group R_{II} of drying cylinders, which may be a conventional group with single-wire draw, the web being brought first into vicinity of the transfer suction roll S_1 in said group, and being transferred further in a conventional group R_{II} of drying cylinders provided with single-wire draw H_1.

Fig. 7B shows an embodiment which is in the other respects similar to that shown in Fig. 7A, but in which there is no separate loop of transfer wire H_3 and in which the web is picked up exclusively by means of the transfer suction roll S_{300} from the transfer belt H_{100} of the first group R_I into the second group R_{II} of drying cylinders.

Fig. 8 shows an embodiment that is in other respects similar to Fig. 1, but in which embodiment the second group R_{II} of drying cylinders is a conventional group of drying cylinders with twin-wire draw. The group of drying cylinders in Fig. 8 additionally differs from the embodiment shown in Fig. 1 in the respect that, in the embodiment of Fig. 8, the reversing rolls E_1,E_2 are placed in the lower position in relation to the drying cylinders K_1,K_2,K_3. In the end of the group R_I, the web W is picked up from the face of the transfer belt H_{100} by means of a transfer suction roll D_{10}, which is placed inside the lower wire loop H_{200} of the second group R_{II} of drying cylinders.

In the embodiments described above in relation to Figs. 4...8, it is obvious that, in connection with the reversing rolls E_1 placed after the drying cylinders, it is additionally possible to fit impingement drying apparatuses, as is illustrated in Figs. 3A and 3B.

In the solution shown in Fig. 9A, in the last press nip, in the place of the lower felt there is a transfer belt H_{100} (TransBelt). Normally the web W is separated from the transfer belt H_{100} directly after the press, but in the solution in accordance with the present invention the web is passed over a turning roll or drying cylinder onto an impingement drying roll. Since, after pressing, the web adheres tightly to the face

of the transfer belt, the web need not be supported in any way during the impingement drying. After the impingement drying unit the web is transferred onto the first drying cylinder, and the drying is continued normally with single-wire draw.

The turning roll or the drying cylinder $12a_n$ of the transfer belt H_{100} can be coated if steel, rubber, or flake graphite cast iron causes problems of adhesion. A second possibility is to employ such a high steam pressure in the cylinder that a film of steam is formed between the web and the cylinder, in which case the web does not adhere to the face of the cylinder.

The roll 100 that is provided with impingement drying units $11a_1$, $11a_2$ can be a smooth roll in this case. On the roll, impingement drying is applied to the web, in which connection the dry solids content of the web becomes higher before the transfer to the geometry with single-wire draw. The hoods of the impingement drying units are denoted with $130a_1$,$130a_2$. In them, the discharge faces for the impingement drying medium, such as air, are placed in the vicinity of the web W, while the web W follows the face of the transfer belt H_{100} along with the face of the roll 100.

Fig. 9A shows the use of the transfer belt H_{100} in connection with the last press $10a_1$,$10a_2$ in the press P, which last press is preferably an extended-nip press, which comprises an extended-nip roll $10a_1$, which is provided with a resilient belt mantle which adapts itself to the shape of the preferably smooth-faced backup roll $10a_2$ while the extended-nip roll is provided with a loading shoe connected with its central axle and placed inside the belt mantle, the shape of the loading face of said loading shoe corresponding to the shape of the face of the backup roll.

In accordance with the invention, the transfer belt H_{100}, to which the web adheres in the nip N_1, is transferred further to the impingement drying units $11a_1$ and $11a_2$, which have been fitted in the vicinity of the face of the large-diameter roll 100. In the embodiment shown in Fig. 9A, the diameter of the roll 100 is 3600 mm, in which case the length of the impingement drying zone is 7.9 metres. The whole

impingement drying assembly in the embodiment of Fig. 9A consists of two parts and comprises the impingement drying units $11a_1$ and $11a_2$. Through each impingement drying unit $11a_1$, $11a_2$, a heat transfer medium, such as warm air or steam, is blown into connection with the web W in order to dry the web.

As is shown in the figure, the transfer belt H_{100} is passed over the alignment rolls $12a_3$,$12a_4$... The upper felt H_N is also passed through the press nip N_1 of the extended-nip press and guided by means of the alignment rolls $13a_1$,$13a_2$... From the transfer belt H_{100} the web W is transferred over the transfer suction roll 300 into the first drying group R_I in the dryer section K, which group is provided with a conventional run H_1 of a drying wire.

The group R_I of drying cylinders in the dryer section K comprises drying cylinders K_1,K_2... and suction cylinders S_1,S_2... (of the VacRoll type). The dryer section K is a conventional construction of a dryer section. It comprises preferably several groups of drying cylinders, but it is an essential feature of the whole construction that the transfer belt H_{100} is placed in the construction so that, by its means, the paper or board web W is transferred from the press section P to the dryer section K.

Example of measures for the geometry shown in Fig. 1 (roll diameter 3600 mm):

- running speed 2000 metres per minute
- rate of evaporation 120 kg (per square metre in an hour)
- diameter of impingement drying roll 3.6 m (coverage 215 degrees)
- increase in dry solids content 45 → 48.5 %.

An increase of 3.5 % in the dry solids content means a considerable improvement in the properties of strength of the web, and the transfer of the web from the cylinder further at this dry solids content is already considerably more reliable than at a dry solids content of 45 %.

In Fig. 9B, in the geometry in accordance with the invention, it is also possible to use an additional impingement drying unit 500 before the turning roll $12a_n$, in which

case the impingement drying would take place on a plane. This solution would provide the advantage that the temperature of the web can be raised before the impingement drying proper. Depending on the length of the unsupported draw, the transfer belt H_{100} can be supported from below, for example, by means of a sufficient number of support rolls $120a_1$,$120a_2$...

Fig. 10 shows an embodiment in the other respects similar to Fig. 9A, but in the embodiment of Fig. 10 the roll 100 has an even larger diameter of 4800 mm, as compared with that shown in the solution of Fig. 9A. In such a case, the length of the impingement drying zone becomes 10 metres. Correspondingly, the increase in the dry solids content produced by the impingement drying is higher than in the solution shown in Fig. 9A.

Fig. 11 shows an embodiment of the invention in which the roll 100 has been substituted for by an oblong impingement drying hood 110 of the impingement drying unit $11a_1$. The run of the transfer belt H_{100} is in the other respects similar to that in the embodiments shown in Figs. 9 and 10. In this embodiment, the run of the transfer belt H_{100} comprises a straight linear run portion D_1 between the last press in the press section P, which last press is preferably an extended-nip press, and the first drying group R_I in the dryer section K. The support rolls $120a_1$,$120a_2$,$120a_3$,$120a_4$, $120a_5$ support the run of the transfer belt H_{100}, and the oblong hood 110 of the impingement drying unit has been fitted on the run D_1 in the embodiment shown in the figure. The length of the impingement drying zone is about 10 metres. In such a case, a considerable drying capacity is achieved. In the way shown in the figure, by means of the suction roll 300 the web is transferred from the face of the transfer belt H_{100} onto the face of the drying wire H_1 of the first drying group R_I in the dryer section K, and further in the dryer section K.

In Fig. 12, an embodiment is shown which is in the other respects similar to Fig. 11, but in the embodiment of Fig. 12 the impingement drying length has been increased by fitting the support rolls $120a_1$,$120a_2$... vertically and by fitting impingement drying units $11a_1$ and $11a_2$ at both sides of the support rolls $120a_1$,$120a_2$...

The support rolls $120a_1$,$120a_2$... are placed so that their axles are placed in a vertical plane Y_1, and the transfer belt H_{100} is passed along the support rolls $120a_1$,$120a_2$... first upwards and, around the last support roll in the vertical stack and after said roll downwards along the corresponding support rolls $120a_1$,$120a_2$... Thus, at each side of the support rolls $120a_1$,$120a_2$..., there are impingement drying units $11a_1$,$11a_2$, through which warm air, steam or some other heating medium is blown into connection with the web W in order to dry the web. The hoods $110a_1$,$110a_2$... of the impingement drying units $11a_1$,$11a_2$ are oblong constructions.

Further, in Fig. 12, a solution is suggested in which the web runs along a linear path by means of a belt upwards (may also take place downwards). It is an advantage of the solution of Fig. 12 that the dryer section becomes considerably shorter in the longitudinal direction. In stead, more space is required in the direction of height.

Fig. 13 shows a construction similar to Fig. 11. The embodiment shown in this figure differs from the embodiment shown in Fig. 1 in respect of the construction of the inlet side of the drying group R_I in the dryer section K. The initial part of the dryer section K comprises suction boxes J_1,J_2 after the suction cylinder M.

Even if, in Figs. 11, 12 and 13, linear long transfer belt draws are illustrated, the invention is not confined to such draws alone, but the transfer belt draw may also be curved if such a shape is preferable in view of the machine geometry, the belt tension to be maintained, or the runnability, or in view of an equivalent factor.